UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
PREVENTION, PESTICIDES AND
TOXIC SUBSTANCES

12/08/99

MEMORANDUM

SUBJECT: **Tetrachlorvinphos: Revised HED Human Health Risk Assessment**. (Chemical ID No. 083701/List A Reregistration Case No. 0321). DP Barcode No. D261626.

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A comprehensive human health risk assessment conducted by the Health Effects Division (HED) for the organophosphate (OP) active ingredient **tetrachlorvinphos** [(Z)-2-chloro-1-(2,4,5-trichlorophenyl)vinyl dimethyl phosphate] was issued 6/16/99 [W. Hazel, D256838]. Subsequently, additional data pertaining to the residential handler and post-application exposure and risk assessments were submitted by Hartz Mountain Corporation (Hartz). This revised document incorporates these new data, to the extent possible, in aggregate exposure and risk assessments. In addition, tables providing details of the tetrachlorvinphos toxicity profile have been added. A revised Quantitative Usage Analysis (QUA), completed by BEAD/OPP (T. Kiely, 11/15/99) has not been incorporated in the current assessment; the new usage data would likely result in slightly lower estimates of dietary exposure.

Attachment: HED Revised Occupational Exposure and Risk Assessment (S. Hanley, 10/25/99, D257557).

cc: Reviewer (CSwartz); C. Olinger (HED/RRB1, 7509C); S. Hanley (HED/RRB1, 7509C); B. Chin (HED/RRB1, 7509C)
7509C:CSwartz:RRB1:CM2:Rm 722H:703 305 5877:12/08/99

Tetrachlorvinphos use patterns supported through reregistration include oral larvicide uses for livestock, direct treatment of beef and dairy cattle (including lactating cattle), horses, poultry and swine; and livestock premise treatments. Homeowner use products allow application to pets and their bedding to control fleas and ticks.

EXECUTIVE SUMMARY

Available data indicate that estimated risks associated with acute, chronic, and carcinogenic dietary exposures are below HED's level of concern. Chronic and carcinogenic dietary risk estimates were refined using anticipated residue data based on metabolism studies and 5/99 Biological and Economic Analysis Division (BEAD) usage data which estimated the percentage of animals treated via direct dermal treatments and livestock feed-through uses. The probabilistic acute dietary risk estimates for livestock tissues were based on the recommended time-limited tolerances estimated from metabolism data, the 5/99 livestock usage data, and milk monitoring data from USDA's Pesticide Data Program (PDP). The revised quantitative usage analysis (QUA, 11/99) would likely result in slightly lower estimates for acute and chronic dietary exposure. Based on the supported use pattern, no dietary exposure to tetrachlorvinphos is expected through drinking water.

Short- (i.e., 1-7 days) and intermediate-term (i.e., >7 days) risk assessments were conducted for occupational workers. Risks for the two time-frames were essentially the same, due to the similarities in the exposure and hazard inputs. HED is most concerned with short-term occupational risks estimated for mixer/loaders/applicators using backpack sprayers; HED's level of concern was greatly exceeded for these scenarios at the maximum level of mitigation possible. The cancer risk estimates for occupational handlers, at the maximum level of mitigation (i.e., additional PPE), were in the 1×10^{-5} range at higher use frequencies, and in the 1×10^{-6} range or lower for lower use frequencies. Since conservative assumptions were used to assess cancer risk, HED is not particularly concerned with cancer risk for occupational handlers. Based on the use pattern, occupational post-application exposure is not expected, and therefore an occupational post-application exposure and risk assessment was not conducted.

Exposure to tetrachlorvinphos in residential settings is expected based on the supported use pattern; therefore, short-term handler and post-application risk assessments were conducted for adults, and a post-application risk assessment was conducted for toddlers, including dermal and oral (hand-to-mouth) exposures. In addition, a cancer assessment was conducted for adults exposed in residential settings. Finally, for scenarios with estimated risks below HED's level of concern, an aggregate exposure and risk assessment was conducted, which combined risk from dietary and residential exposure sources.

The Hartz Mountain Corporation (Hartz) data were incorporated into the assessment to the extent possible. Due to study quality issues, the residential handler data generated for the dip scenarios could not be used in the handler exposure and risk assessment; however, the pet collar handler studies were incorporated into the residential handler assessment. The fur dissipation data

were used to estimate post-application exposure; the revised labels and marketing data were incorporated into the assessment as well.

Estimated short-term and carcinogenic risk for residential handlers was above HED's level of concern for scenarios involving application of dips and powders. For application of a powder, the application rate was determined from the chemical-specific post-application studies, but other parameters were taken from the SOPs for Residential Exposure Assessment; therefore, the calculated risks are considered to be conservative. For the dip scenarios, the chemical-specific data could not be used, and therefore the handler assessment was based entirely on assumptions and approaches described in the Residential SOPs. Additional chemical-specific data for the dip scenarios, in which the active ingredient (rather than a simulated dip) is applied, would allow HED to further refine the assessment. Estimated short-term and carcinogenic risk for handlers were below HED's level of concern for the pump spray, aerosol and pet collar application scenarios.

Post-application exposure to tetrachlorvinphos following application of a pet collar was considered to be negligible; dermal post-application exposure and risk for adults having contact with treated pets following application of dips, powders and aerosols were below HED's level of concern. Dermal exposure estimates for toddlers were generally below the level of concern, with the exception of the aerosol scenario at the maximum application rate, for which the estimated risk was at or just above the level of concern. Exposure resulting from toddler hand-to-mouth activity following dermal exposure to treated pets resulted in estimated risks below the level of concern for powders, pumps and aerosols at average application rates, and for dips at average and maximum rates. Risks were above the level of concern for hand-to-mouth exposures following contact with pets treated at the maximum application rates for powders, aerosols and pump sprays.

Aggregate risk assessments conducted for tetrachlorvinphos included dietary (food only), handler and post-application exposures for adults, and post-application dermal, oral (hand-to-mouth) and dietary food (only) exposures for toddlers. In addition, an aggregate cancer assessment was conducted for adults. Since dietary exposure through drinking water is not expected based on the supported use patterns, the acute aggregate risk is equivalent to the acute dietary risk from food, as described above.

For adults, short-term aggregate risk was below HED's level of concern for aerosol and pump spray scenarios. For dip and powder scenarios, individual components of aggregate risk were above the level of concern, and therefore these scenarios could not be aggregated. Aggregate short-term risks to toddlers following contact with a treated pet were above the level of concern for all scenarios except the dip. While some conservative assumptions from the SOPs for Residential Exposure were used, the assessment also incorporated the chemical-specific dissipation data.

Aggregate cancer risks for adults were above HED's level of concern for dip scenarios and

application of powders. All other estimated aggregate cancer risks were below HED's level of concern for a single use of a product, and for use of a topical product in conjunction with application of a pet collar.

In summary, HED has concerns for potential risks associated with residential handlers' exposure to dips; due to the poor quality of the chemical-specific data, HED used the assumptions described in the SOPs for Residential Exposure Assessment. Estimated risks associated with use of powders exceed the level of concern, even though some chemical-specific data were used to assess exposure. Additional chemical-specific data addressing these scenarios may help HED further refine these assessments.

A summary of incident reports associated with tetrachlorvinphos usage was presented in the J. Blondell and M. Spann memo dated 7/8/98; relatively few incidents have been reported, and there were no regulatory recommendations made on the basis of these few incidents. Available domestic animal safety data address potential affects of dermal application to cats and dogs; however, no data are available regarding the feed-through uses. Veterinary incidents involving horses treated with feed-through products for fly control have recently been reported; HED is in the process of reviewing the information.

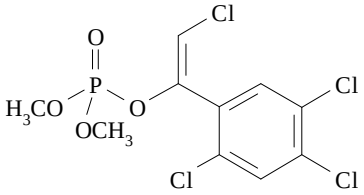
DETAILED CONSIDERATIONS

PHYSICAL/CHEMICAL PROPERTIES

Technical tetrachlorvinphos is a tan to brown crystalline solid with a melting point of 93-98 C and a bulk density of 50-55 lb/cu ft. The solubility of tetrachlorvinphos in water at 24 C is 15 ppm. Tetrachlorvinphos has limited solubility in most aromatic hydrocarbons (i.e., 40 ppm in chloroform and dichloromethane, 20 ppm in acetone, and 8 ppm in xylene at 0 C).

Other identifying codes and characteristics are as follows:

Empirical Formula:	$C_{10}H_9Cl_4O_4P$
Molecular Weight:	366.0
CAS Registry No.:	22248-79-9
PC Code:	083701



tetrachlorvinphos

HAZARD CHARACTERIZATION

Hazard Profile

Tetrachlorvinphos has relatively low acute toxicity in rats via oral and inhalation routes, and low acute toxicity via the dermal route in rabbits; based on studies conducted in guinea pigs, it is considered to be a dermal sensitizer. In subchronic and chronic toxicity studies conducted in rats and dogs, red blood cell (RBC) and plasma cholinesterase inhibition (ChEI) were observed at doses ranging from 43.2 to 1000 mg/kg/day. Systemic effects observed in these studies included reduced body weights and body weight gains, liver effects including increased liver weights, thyroid effects, and increased kidney weights. Clinical signs of neurotoxicity were not observed in the subchronic and chronic studies.

Developmental and reproductive toxicity studies conducted in rats and rabbits indicate no increased sensitivity of developing young relative to maternal animals due to either pre- or post-natal exposure to tetrachlorvinphos. In acute and subchronic neurotoxicity studies conducted in rats, transient clinical signs characteristic of cholinesterase inhibition were observed, but ChEI was not measured; LOAELs and NOAELs in these studies were either similar to or higher than those in the chronic and subchronic toxicity studies.

In an acute delayed neurotoxicity study conducted in hens, no clinical signs of neurotoxicity or neuropathology were observed; however, inhibition of neurotoxic esterase (NTE) was not assessed.

Tetrachlorvinphos is considered to be a possible human (Group C) carcinogen based on statistically significant increases in combined hepatocellular adenoma/carcinomas in mice, and suggestive evidence of thyroid c-cell adenomas and adrenal pheochromocytomas in rats. A cancer potency factor (Q_1^*) of 1.83×10^{-3} $(mg/kg/day)^{-1}$ was estimated using the time-to-tumor model.

Details of toxicology studies submitted for tetrachlorvinphos are presented in the 4/98 version of the HED RED, and the results are summarized in Tables 1 and 2.

Table 1. Acute Toxicity of Tetrachlorvinphos Technical.

Guideline No.	Study Type	MRID No.	Results	Toxicity Category
870.1100	Acute Oral - Rat	41222504	LD_{50} = 1480 mg/kg (M) 465-965 mg/kg (F)	III
870.1200	Acute Dermal - Rabbit	41222505	LD_{50} > 2000 mg/kg	III
870.1300	Acute Inhalation - Rat	00138933	LC50 > 3.61mg/L	III
870.2400	Acute Eye Irritation - Rabbit	41222506	moderate	III
870.2500	Acute Dermal Irritation - Rabbit	41222507	slight	IV
870.2600	Skin Sensitization - Guinea Pig	41377902 42981001	sensitizer	
870.6100	Acute Delayed Neurotoxicity	41905901	No clinical signs of neurotoxicity observed (NTE not measured)	

Table 2. Toxicity Profile of Tetrachlorvinphos Technical.

Study Type	MRID No.	Results	Effects
Acute Neurotoxicity Study -Rat	42912501	NOAEL=65 mg/kg/day LOAEL=325 mg/kg/day	Transient clinical signs characteristic of ChEI
Subchronic Neurotoxicity -Rat	43294101	NOAEL=250 mg/kg/day LOAEL=Not established	Cholinesterase activity not measured
21-Day Dermal Toxicity - Rat	41342001	NOAEL=100 mg/kg/day (F) NOAEL=1000 mg/kg/day (M) LOAEL=1000 mg/kg/day (F)	Plasma ChEI
Subchronic Feeding - Rat	43371201	NOAEL=4.23 mg/kg/day LOAEL=43.2 mg/kg/day	Plasma and RBC ChEI
Chronic Feeding - Dog	42679401	NOAEL=6.25 mg/kg/day LOAEL=500 mg/kg/day	Decreased: RBC counts, hemoglobin, hematocrit, and urine specific gravity
Chronic Feeding - Dog	00077819	NOAEL=3.13 mg/kg/day LOAEL=50 mg/kg/day	Plasma ChEI; increased liver and kidney weights
Chronic Feeding - Rat	00112525	NOAEL=1.25 mg/kg/day LOAEL=6.25 mg/kg/day	Increased liver weights in females
Chronic Feeding - Rat	42980901	NOAEL=4.23 mg/kg/day LOAEL=43.2 mg/kg/day	Histological changes in liver/adrenal glands, reduced weight gain, plasma ChEI in females

Table 2. Toxicity Profile of Tetrachlorvinphos Technical.

Study Type	MRID No.	Results	Effects
Carcinogenicity - Mouse	00126039	NOAEL(systemic)=240 mg/kg/day LOAEL(systemic)=1200 mg/kg/day	Decreased weight gain. Statistically significant increased hepatocellular carcinoma, combined adenoma/carcinoma and adenomas
Carcinogenicity - Mouse NCI-sponsored	00117443	N/A	Increased incidences of hepatocellular carcinomas and granulomatous lesions in liver
Carcinogenicity - Rat NCI-sponsored	00117443	N/A	Increased incidences of adrenal cortical adenomas and thyroid C-cell adenomas
Developmental Toxicity -Rat	40152701 42520101	Maternal NOAEL=75 mg/kg/day LOAEL=150 mg/kg/day Developmental NOAEL=300 mg/kg/day LOAEL=Not established	Maternal: decreased body weight gain
Developmental Toxicity -Rabbit	00127831	Maternal NOAEL=375 mg/kg/day LOAEL=750 mg/kg/day Developmental NOAEL=375 mg/kg/day LOAEL=750 mg/kg/day	Maternal: mortality, abortions, red vaginal fluid; Developmental: increase in early resorptions/dam with an increase in post-implantation loss and a decrease in live fetuses/dam.
Reproductive Toxicity -Rat	42054301	Parental/systemic NOAEL=25 mg/kg/day LOAEL=100 mg/kg/day Offspring NOAEL=100 mg/kg/day LOAEL=Not established	Parental: Decreased body weight gains, increased adrenal gland weights (F)
Gene Mutation - *Salmonella*	41222508	Non-mutagenic (±) activation	
CHO Assay	41312901	Positive without S9 activation Negative with S9 activation	
Unscheduled DNA synthesis	42156401	Negative	
Metabolism -Rat	41988401	Tetrachlorvinphos was rapidly metabolized and excreted in the urine (46-60%) and feces (38-56%) within 48 hours of dosing. Only minor amounts of radioactivity were found in tissues. The major metabolite in feces was trichlorphenylethanol; the major metabolite in urine was trichloromandelic acid. Other metabolites included desmethyl tetrachlorvinphos and trichlorophenylethandiol.	

Dose Response and FQPA Considerations

Selection of endpoints for tetrachlorvinphos risk assessments was discussed in detail in the 4/98 HED RED Chapter. When endpoint selections for all organophosphates were evaluated for consistency, the HIARC determined that acute dietary and short- and intermediate-term occupational and residential exposure assessments should be conducted for tetrachlorvinphos. A summary of endpoints for risk assessment is presented in Table 3.

The acute dietary endpoint was selected from an oral subchronic toxicity study conducted in rats, in which plasma and RBC cholinesterase inhibition were observed at the LOAEL of 43.2 mg/kg/day; the NOAEL of 4.32 mg/kg/day is used for acute dietary risk assessment. Although cholinesterase inhibition (ChEI) was measured only at the conclusion of the study (13 weeks), the HIARC concluded that the effects could have occurred after a single dose (as demonstrated for other OPs); although clinical signs of neurotoxicity were observed in the acute neurotoxicity study, the study did not assess ChEI. Consequently, the ChEI endpoint was selected from the subchronic study.

The Committee recommended using the endpoint and NOAEL selected from the subchronic toxicity study (ChEI, 4.32 mg/kg/day) for short- and intermediate-term occupational and residential exposure assessments. The Committee had previously selected a dermal absorption factor of 9.57% for dermal exposures, and a 100% absorption factor for inhalation exposures. Although the oral reference dose established based on a chronic study in rats was selected for long-term occupational and residential exposure assessments, long-term or chronic exposures are not expected, based on supported use patterns.

Since all the endpoints were selected from animal studies, the conventional safety factors of 10X for intra-species variability and 10X for inter-species extrapolation were applied to determine acceptable margins of exposure (MOEs). The FQPA safety factor was reduced to 1X for tetrachlorvinphos (see FQPA Safety Factor Recommendations for the Organophosphates, 8/6/98). A reference dose (RfD) which includes the FQPA safety factor (10X, 3X or 1X) is defined as the Population Adjusted Dose (PAD). In the case of tetrachlorvinphos, the acute and chronic PADs (aPAD and cPAD) for the general U.S. population and various population subgroups are equivalent to the acute and chronic RfDs selected by the HIARC. Doses and endpoints for dietary risk assessment are presented in Table 3.

Table 3. Tetrachlorvinphos: Toxicological Endpoints for Risk Assessment.[1]

EXPOSURE SCENARIO	DOSE (mg/kg/day) UF[2]	ENDPOINT	STUDY
Acute dietary	4.23 (NOAEL) 100X (Conventional) 1X (FQPA)	Plasma/RBC ChE Inhibition at 13 weeks (43.2)	Subchronic Rat
	aRfD = aPAD = 0.0423 mg/kg/day		
Chronic dietary (non-cancer)	4.23 (NOAEL) 100X (Conventional) 1X (FQPA)	Histological liver and adrenal changes (43.2); reduced weight gain/plasma ChE Inhibition in females.	Chronic Rat
	RfD = cPAD = 0.0423 mg/kg/day		
Cancer	$Q_1^* = 1.83 \times 10^{-3}$	Based on adenomas/carcinomas and pheochromocytomas	Mouse carcinogenicity
Short-/Intermediate-Term dermal	4.23 (NOAEL) 100X (Conventional) 1X (FQPA) MOE=100	Plasma/RBC ChE Inhibition at 13 weeks (43.2) Use Dermal Absorption Factor of 9.6%	Subchronic Rat
Short-/Intermediate-Term inhalation	4.23 (NOAEL) 100X (Conventional) 1X (FQPA) MOE=100	Plasma/RBC ChE Inhibition at 13 weeks (43.2) Use Inhalation Absorption Factor of 100%	Subchronic Rat

[1] ChE = Cholinesterase; RBC = red blood cell (erythrocyte). Reference Dose = RfD = NOAEL/UF; PAD = Population Adjusted Dose =RfD/FQPA Factor; MOE = Margin of Exposure= UF for occupational assessments, and UF*FQPA Factor for residential assessments.

[2] Conventional UF of 100 includes 10X for inter-species extrapolation and 10X for intra-species variability. The FQPA SF was reduced to 1X for tetrachlorvinphos.

EXPOSURE ASSESSMENT

Summary of Registered Uses

Tetrachlorvinphos uses supported through reregistration include oral larvicide uses for livestock, direct dermal treatment of beef and dairy cattle (including lactating dairy cattle), horses, poultry and swine, and livestock premise treatments. In residential settings, products containing tetrachlorvinphos may be applied to pets and their bedding to control fleas and ticks.

HED has recommended revocation of tolerances established in conjunction with application to plants, for which all registrations were voluntarily canceled in 1987. The existing tolerances recommended for revocation are for residues of tetrachlorvinphos *per se* in alfalfa; apples; cherries; field, pop and sweet corn fodder and forage; fresh and sweet corn; corn grain; cranberries; peaches; pears; and tomatoes.

Based on the supported use patterns, there is no dietary exposure to tetrachlorvinphos expected through consumption of drinking water. Therefore, the aggregate risk assessment considers only dietary food and residential (including hand-to-mouth) exposures.

Dietary (Food) Exposure

Based on livestock metabolism data, the tolerance expression for tetrachlorvinphos [40 CFR §180.252] should be amended to include the combined residues of tetrachlorvinphos *per se* and its metabolites des-O-methyl tetrachlorvinphos, 1-(2,4,5-trichlorophenyl)ethanol (free and conjugated forms), 2,4,5-trichloroacetophenone, and 1-(2,4,5-trichlorophenyl)ethanediol. Time-limited tolerances for residues in livestock commodities must be maintained, reflecting feed-through and direct dermal uses on livestock; the recommended time-limited tolerances are based on livestock metabolism data, and exceed existing tolerances for residues in some commodities. Permanent tolerances will be established when adequate magnitude of the residue data for ruminants, swine and poultry are submitted (protocols are under review). Residues included in dietary exposure estimates for incorporation into chronic and carcinogenic risk assessments are tetrachlorvinphos and the four metabolites containing the 2,4,5-trichlorophenyl moiety named above that have been recommended for inclusion in the tolerance expression. Tetrachlorvinphos *per se* is the only residue of concern for acute dietary exposure.

In conducting dietary exposure assessments, HED uses consumption data from USDA's Continuing Surveys of Food Intake by Individuals, 1989-1992. The consumption data are coupled with residues in commodities to determine dietary exposure using the Dietary Exposure Evaluation Model (DEEM™) software.

For chronic dietary risk assessments, the DEEM™ software estimates total dietary exposure to pesticides in foods based on mean consumption data. For acute dietary risk assessments, DEEM™ estimates short term (daily) total dietary exposure from individual consumption data. For both acute and chronic dietary exposures, DEEM™ calculates risk by comparing estimated dietary exposure to the doses of regulatory concern (i.e., the aPAD and cPAD) for risk assessment identified by the HIARC.

Refined residue estimates for acute and chronic dietary exposure analysis, generated in conjunction with the HED RED (4/1/98) and used in previous dietary risk analyses, were updated using the 5/99 QUA. Details regarding calculation of the anticipated residues are provided in the C. Olinger memo (6/16/99; Attachment 1); the refined anticipated residues in livestock commodities are considered to be conservative because of the type of data used (i.e., results of

livestock metabolism studies) and because no refinements were made for potential loss of residues during cooking/baking.

In the current chronic and cancer analyses, the weighted average of percent livestock treated was used as a correction factor; for the acute analysis, the estimated (or likely) maximum of percent livestock treated was used. This is a departure from previous HED policy, which dictated use of the estimated maximum percent livestock/crop treated in all analyses.

Acute, chronic and cancer dietary exposure analyses conducted for tetrachlorvinphos incorporated DEEM™ default concentration factors. Residue Distribution Files (RDF) were constructed for the probabilistic acute dietary risk assessment using anticipated residues from livestock metabolism studies for tissues and USDA/Pesticide Data Program (PDP) monitoring data for milk. Adjustment for percent livestock treated was made in the RDFs for livestock commodities. For chronic and cancer dietary risk assessments, percent livestock treated adjustments were made in the DEEM™ analysis. In chronic and cancer risk assessments, the calculated exposure was compared to the chronic Population Adjusted Dose (cPAD) of 0.04 mg/kg/day and the Q_1* of 1.83×10^{-3} $(mg/kg/day)^{-1}$, respectively. In the acute risk assessment, the calculated exposure was compared to the acute Population Adjusted Dose (aPAD) of 0.0423 mg/kg/day.

Using the recommended time-limited tolerances, estimated carcinogenic dietary risk for the U.S. Population was 7.9×10^{-6} which exceeds the Agency's level of concern (one in a million excess cancers). Refinement of the exposure analysis with anticipated residue data and the 5/99 percent livestock treated data resulted in an estimated carcinogenic dietary risk of 1.8×10^{-7} for the general U.S. population, which is below the Agency's level of concern for carcinogenic dietary risk.

Refined acute and chronic dietary risk are considerably less than 100% of the aPAD and cPAD, and are therefore considered to be below the Agency's level of concern for acute and chronic dietary risk. These refined risk figures are compared with assessments using time-limited tolerances (as opposed to ARs) and also, for acute risk only, deterministic as opposed to probabilistic approaches. Refer to Table 4 for details. Dietary risks estimated using time-limited tolerances are conservative, since the time-limited tolerances were derived from upper-bound residues determined in metabolism studies. However, even the refined risk estimates are considered to be conservative, since anticipated residues were also derived from metabolism data.

Acute dietary exposure estimated using time-limited tolerances resulted in risks below HED's level of concern. The most highly exposed subgroup was children 1-6 years, with 52% aPAD consumed at the 95th percentile of exposure (Table 4); the exposure estimate for the general U.S. population corresponded to 29% aPAD consumed. Refinement of the acute dietary exposure estimates using anticipated residues resulted in 47% aPAD for children 1-6 years, and 26% aPAD for the general U.S. population, both at the 95th percentile of exposure. A probabilistic analysis which incorporated livestock usage data reduced the risk for children 1-6 years to 40% aPAD and

the risk for the general U.S. population to 22% aPAD, both at the 99.9th percentile of exposure. Examination of the critical exposure contribution analysis revealed that exposure at the 99.9th percentile is largely due to consumption of meats (beef, poultry, and pork).

Chronic dietary exposure and risk estimates indicate the most highly exposed population subgroup is children 1-6 years, with 21% of the cPAD consumed based on use of time-limited tolerances (Table 4). When refined residue estimates and usage data were incorporated in the analysis, chronic dietary risk was estimated to be <1% cPAD for the general U.S. population and all population subgroups; children 1-6 years were highest, at 0.5% cPAD.

Table 4. Acute and Chronic (Non-Cancer) Dietary Exposure/Risk.

Population Subgroup	Acute **Time-Limited Tolerances** (95th %-ile)		Acute **Anticipated Residues (Deterministic)** (95th %-ile)		Acute **Anticipated Residues (Probabilistic**) (99.9th %-ile)		Chronic **Time-Limited Tolerances**		Chronic **Anticipated Residues**	
	Exposure (mg/kg/day)	%aPAD	Exposure (mg/kg/day)	%aPAD	Exposure (mg/kg/day)	%aPAD	Exposure (mg/kg/day)	%cPAD	Exposure (mg/kg/day)	%cPAD
U.S. Population	0.012186	29	0.010886	26	0.009345	22	0.004339	10	0.000100	<1
All infants (<1 yr)	0.013767	33	0.011184	26	0.012012	28	0.002664	6.3	0.000060	<1
Nursing infants (<1 yr)	0.008179	19	0.007516	18	0.003347	7.9	0.000983	2.3	0.000013	<1
Non-nursing infants (<1 yr)	0.015706	37	0.012590	30	0.014303	34	0.003371	8.0	0.000080	<1
Children (1-6 yrs)	0.021908	52	0.019692	47	0.017076	40	0.008855	21	0.000193	<1
Children (7-12 yrs)	0.015250	36	0.013633	32	0.010971	26	0.006238	15	0.000140	<1
Females (13-19 yrs)	0.010088	24	0.009548	23	0.008237	19	0.003923	9.3	0.000090	<1
Females (20+ yrs)	0.008426	20	0.007935	19	0.006770	16	0.003217	7.6	0.000080	<1
Males (13-19 yrs)	0.010991	26	0.009821	23	0.008496	20	0.004595	11	0.000095	<1
Males (20+ yrs)	0.009821	23	0.009130	22	0.007606	18	0.003860	9.1	0.000087	<1

Occupational and Residential Exposure

Usage Information

Tetrachlorvinphos is marketed in a variety of end-use products that include dusts, emulsifiable concentrates, wettable powders, treated articles, granulars for livestock feed-through purposes, and ready-to-use products (i.e., pressurized sprays and liquids). Tetrachlorvinphos concentrations in various formulations are: dusts (1 to 3 percent), emulsifiable concentrates (2.8 to 24 percent), wettable powders (50 to 75 percent), treated articles (approximately 15 percent), granulars for livestock feed-through purposes (<10 to approximately 98 percent), and ready-to-use products (1 to 2 percent). The most significant market for tetrachlorvinphos products (in terms of pounds active ingredient applied) is allocated to uses on poultry. The sites with a high percentage of their total U.S. animals treated include horses (16%), and dogs and cats (10%).

Products containing tetrachlorvinphos are intended for use by individuals in the normal course of employment (i.e., they can be occupationally exposed), and can also be purchased and used by homeowners. Some occupational uses can lead to general population exposures in a residential setting (e.g., veterinary or groomer uses on domestic pets). Exposures are typically addressed for those who are involved in the application of pesticides (i.e., handlers or applicators) and those who are exposed to pesticides but who have not directly used them (i.e., post-application exposures). Handlers include professional applicators and homeowners. Post-application exposures include agricultural harvesters or children playing with a treated animal. HED anticipates that handler exposures occur in occupational settings, and that both handler and post-application exposure pathways exist for tetrachlorvinphos in residential settings. Handler exposure scenarios are limited to direct animal, premise and feed-through treatments. These scenarios generally indicate that handlers make applications using: ready-to-use packaging, handheld spray equipment, and specialized equipment (e.g., for animal dipping and feed-through applications).

All occupational tetrachlorvinphos exposures were considered to be either short- (i.e., 1-7 days) or intermediate-term (i.e., 8 days to several months) in nature; only short-term exposures were considered in residential settings. No chronic exposure scenarios (i.e., 180 days or greater) are thought to exist for tetrachlorvinphos. A cancer assessment was completed using the cancer potency factor (Q_1*) value estimated by the CPRC and lifetime average daily dose levels (LADDs). Numerical values of short-term and intermediate-term risks were identical due to the similarity of the exposure and hazard components of the risk. Toxicology endpoints for dermal exposures were selected from oral studies. Therefore, a chemical-specific dermal absorption factor (relative to oral dosing) of 9.6% was selected by the HIARC and used in the dermal component of all tetrachlorvinphos exposure and risk assessments. For inhalation exposures and risks, an inhalation absorption factor of 100% was used. For handler risk assessments, dermal and inhalation exposures were combined into a total dose; for post-application risk assessments, only dermal exposure was considered.

Following completion of the 6/99 HED risk assessment for tetrachlorvinphos, Hartz submitted new data consisting of eight exposure studies to address and further refine the residential handler and post-application risk assessments. The handler data generated for pet collar application have been incorporated into the residential handler assessment. However, due to significant deficiencies in the dip handler studies (i.e., low replicate numbers, poor quality control, lack of validated techniques), the results could not be used in the residential handler assessment. The results of the post-application studies, which consisted of fur dissipation data, were incorporated into the residential post-application risk assessment. Marketing data were submitted to support a refined residential exposure analysis. These data were not specific to tetrachlorvinphos, but largely supported the results of the National Home and Garden Pesticide Use Survey. Data from the marketing analysis were incorporated into HED's assumptions for frequency of application. Finally, the registrant submitted amended labels which modified application rates and more clearly defined the amount of product applied per application.

Occupational Handler Exposure/Risk

Handler assessments were completed for mixer/loaders preparing spray solutions using liquid and wettable powder formulations for applications using handheld equipment and for loading granulars into metering systems for feed-through purposes. Applicator (and combined mixer/loader/applicator) exposures were assessed for commonplace handheld equipment types including backpack, high pressure handwand, and low pressure handwand sprayers. Applicator exposures were also considered for animal dusting and aerosol can treatments (e.g., livestock and pets).

If estimated risk exceeds HED's level of concern when baseline exposure assumptions are used, three basic risk mitigation approaches are considered appropriate for controlling occupational exposures. These include administrative controls, the use of personal protective equipment (PPE), and the use of engineering controls. Occupational handler exposure assessments are completed using a baseline exposure scenario and, if required, increasing levels of risk mitigation (PPE and engineering controls) to achieve an appropriate margin of exposure (MOE) or cancer risk. The baseline clothing/PPE ensemble for occupational exposure scenarios generally consists of an individual wearing long pants, a long-sleeved shirt, no chemical-resistant gloves (except where noted), and no respirator. The first level of mitigation generally applied is PPE; for tetrachlorvinphos, PPE involves the use of an additional layer of clothing, chemical-resistant gloves, and a respirator.

The next level of mitigation considered in the risk assessment process is the use of engineering controls which, by design, attempt to eliminate the possibility of human exposure. Examples of commonly used engineering controls include closed tractor cabs, closed mixing/loading/transfer systems, and water-soluble packets. The use of a tiered mitigation approach was used in the completion of the handler exposure and risk assessment for tetrachlorvinphos. One chemical-specific handler exposure study was submitted in support of the reregistration of tetrachlorvinphos in which separate mixer/loader and applicator exposures were quantified during

application of a WP formulation in poultry houses. Most exposure scenarios were addressed using the data from the *Pesticide Handlers Exposure Database (PHED V1.1)*. PHED is a generic database containing voluntarily submitted empirical exposure data for workers involved in the handling or application of pesticides in the field, and currently contains varying quality data for over 2000 monitored exposure events. The underlying assumption supporting use of PHED data is that exposure to pesticide handlers can be calculated generically (based on the available empirical data), since exposure is primarily a function of the physical parameters of the handling and application process (e.g., packaging type, formulation type, application method, and clothing scenario).

To ensure consistency in the risk assessment process, a surrogate exposure table that contains a series of standard unit exposure values for various occupational exposure scenarios has been developed using PHED (*PHED Surrogate Exposure Guide of May, 1997*). This guide serves as the basis for the tetrachlorvinphos exposure assessment.

Equipment type and the nature of mixing/loading operations generally define exposure scenarios included in pesticide handler exposure/risk assessments. These scenarios are further refined by application rate ranges and differences in cultural practice (e.g., acres or gallons applied per day vary based on crop). Nine occupational handler scenarios were identified for tetrachlorvinphos; associated exposures and risks were calculated for handlers at all levels of risk mitigation. Mitigation was applied to specific scenarios as required until an acceptable level of risk was attained or until the options for risk mitigation were exhausted.

Four major input parameters are needed to complete handler risk assessments including unit exposure values specific to the application equipment and level of risk mitigation; application rate; amount that can be treated in a day; and the toxicology parameters. Chemical-specific data discussed above were used to address relevant scenarios, and PHED was used to complete the remaining exposure assessments. In the tetrachlorvinphos handler exposure assessment, data for most scenarios where PHED was used are considered to be low to medium confidence. However, the assessment is considered to be conservative, since maximum application rates were assumed, even though they are not commonly used.

Since tetrachlorvinphos is a suspected human carcinogen, it is assumed that any amount of exposure will lead to some degree of carcinogenic risk. No chemical-specific use data were available to develop a typical application rate and frequency for the cancer component of the risk assessment. Therefore, the maximum application rates for all scenarios were used to complete the cancer assessment. In addition, conservative amortization parameters, such as weekly use over 35 working years, were used to calculate the LADD values; based on the usage data provided by BEAD, HED considers this type of use pattern to be unlikely. The estimate of animals per day is considered to be a reliable estimate of what can be done on a single, very productive day; the daily treated values used in determining tetrachlorvinphos exposures are standard inputs routinely used by the HED, and are considered to be conservative for estimating cancer risk.

Short- and intermediate-term risks to handlers are expressed in terms of the margin of exposure (MOE), which is a ratio of the regulatory dose of concern (NOAEL) to the estimated exposure. For tetrachlorvinphos, the target MOE is 100 for both short- and intermediate-term assessments. Therefore, HED has concerns when estimated MOEs are less than 100.

Exposure was assessed for nine occupational handler scenarios. At the baseline clothing scenario, the level of concern was exceeded for handlers mixing/loading a wettable powder (MOE of 19), for applicators using a high-pressure handwand (MOE of 30), and for mixer/loader/applicators using a backpack sprayer (MOE of 1.8). Estimated risk for the remaining scenarios was below the level of concern, with MOEs ranging from 100 to 3700. No data were available to assess exposures for applying dusts or pellets. With the use of additional PPE, exposure for handlers mixing/loading a wettable powder was below the level of concern, with an estimated MOE of 300; applicators using a high-pressure handwand had an estimated MOE of 94, which is at or just above the level of concern. However, even with the use of additional PPE, the level of concern was exceeded for mixer/loader/applicators using a backpack sprayer, with MOEs of 3.8 and 6.4 (the higher of the two represents a double layer of clothing).

Cancer risks were calculated using a Q_1^* value of 1.83×10^{-3} $(mg/kg/day)^{-1}$ by calculating a lifetime average daily dose (LADD) over a 70 year lifetime. Over this lifetime, individuals were expected to have an average working life of 35 years and to handle tetrachlorvinphos from 3 times per year to one time per week over their working lifetime. Occupational cancer risks of less than 1×10^{-4} were achieved for all scenarios using baseline clothing assumptions, with the exception of mixer/loader/applicators using a backpack sprayer, and assuming maximum label use over 6 months or one year; the estimated cancer risks for this scenario were 1.5×10^{-4} to 3.6×10^{-4}. Mitigation through addition of PPE (i.e., additional clothing and gloves) resulted in estimated cancer risks of 4.2×10^{-5} and 8.4×10^{-5} for backpack scenarios assuming more frequent use, and 5.0×10^{-6} for the lower use frequency. For all other scenarios, estimated cancer risks (assuming use of additional PPE) ranged from 2.7×10^{-8} to 2.9×10^{-6}.

Varying quality PHED data (i.e., ranging from low to high confidence, depending on the scenario) were used to complete the short- and intermediate-term occupational handler assessments; the assumption of maximum application rates for all scenarios lends a degree of conservatism to the overall exposure and risk estimates for occupational handlers. Since the estimated MOEs were considered to be protective for most scenarios, sometimes by large percentages or orders of magnitude, the quality of the PHED data is not critical in characterizing the estimated risks. The cancer risk estimates for occupational handlers are conservative, since they encompass the maximum use rates and frequencies over the entire working life, which is considered to be unlikely for products containing tetrachlorvinphos.

Occupational Post-application Exposure/Risk

Tetrachlorvinphos uses supported through reregistration are not expected to result in significant occupational post-application exposures. Therefore, an occupational post-application exposure

and risk assessment was not performed.

Residential Handler Exposure/Risk

Handler assessments were completed for individuals applying ready-to-use liquid spray solutions (pressurized aerosols and pump sprays), when dipping or dusting dogs, and when placing a flea collar on an animal.

In residential settings, risk mitigation is not considered to be a viable option in the same manner that it is used in the occupational setting (e.g., extra clothing and a respirator would not be viable on a modern homeowner label because of a lack of training and the ability to enforce such requirements). The only viable risk mitigation options are those inherent in the packaging and formulation such as single use or closed system/coupling products. Exposure data currently used in HED assessments do not allow for evaluation of the manner in which subtle product and packaging refinements affect exposure. Therefore, residential handlers exposure to tetrachlorvinphos was assessed for homeowners wearing short pants and a short-sleeved shirt, which is the typical assumption used in HED residential exposure assessments.

The additional data pertaining to handler exposures submitted by Hartz were used to assess residential exposure during application of a flea collar. As stated previously, the handler data for the dog dip could not be used due to poor study quality. However, average and maximum application rates determined in these studies were used in the current assessment, whereas maximum rates were used in previous assessments.

Four major input parameters are needed to complete residential handler risk assessments, including unit exposure values specific to the application equipment and clothing assumptions; application rate; the amount that can be treated in a day; and the toxicology parameters. Residential handler exposure calculations were completed either using some PHED data (used as described above for occupational handlers) or using the approaches described in the *Standard Operating Procedures for Residential Exposure*. The only chemical-specific residential handler data were from the submitted pet collar application study.

A total of five residential handler scenarios were identified: dusting a dog; dipping a dog; using an aerosol can; using a pump sprayer; and placing a flea collar on a pet. Short-term residential handler risks were below HED's level of concern for scenarios involving the use of an aerosol can or pump spray (MOEs of 3200-5000) and applying a pet collar (MOEs of 220 and 300). However, estimated risks were above HED's level of concern for the dip and powder application scenarios; estimated MOEs for these scenarios ranged from 4 to 21.

Residential handler cancer risks were calculated using a Q_1* value of 1.83×10^{-3} $(mg/kg/day)^{-1}$ coupled with a lifetime average daily dose (LADD) over a 70 year lifetime. Over this lifetime, handlers were expected to own pets for either 20 or 40 years of their lives and to treat their pets (or pet living areas) monthly to weekly; use of 2 pet collars per year was assumed. Cancer risks

calculated for residential handlers were below HED's level of concern of one in one million (1 x 10^{-6}) for the aerosol can, pump spray, and pet collar application scenarios; estimated risks for these scenarios ranged from 6.0 x 10^{-9} to 6.9 x 10^{-7}. However, estimated cancer risk to handlers for dip and powder application scenarios exceeded HED's level of concern, with risks ranging from 1.5 x 10^{-6} to 7.1 x 10^{-6}.

The PHED data used to determine short- term and cancer risks for residential handlers were the best available but are still only considered to be medium confidence data due to analytical quality and the number of data points. Both short-term and cancer risks were assessed assuming maximum and average application rates. The assumptions and approaches described in the SOPs for Residential Exposure Assessment are generally considered to be conservative. Certain amortization parameters used to calculate the LADD values, including the assumption of 20 or 40 years of pet ownership and a treatment frequency as high as once/week during the 20-40 years, are generally considered to be conservative for estimating cancer risk. This characterization is supported by data from the National Home and Garden Pesticide Use Survey completed by the Agency in 1992, and by the registrant's submitted market data. For example, exclusive use of products containing tetrachlorvinphos over a 20- or 40-year period is considered to be unlikely.

Residential Post-application Exposure/Risk

Since tetrachlorvinphos is used for direct animal and animal premise treatment in a residential environment, post-application exposure is expected to occur. However, the use of pet collars is considered to result only in handler exposure during placement on the pet; post-application exposure to tetrachlorvinphos resulting from use of pet collars is considered to be negligible. Some significant short-term residential exposure scenarios that have been identified include contact with previously treated pets including adult dermal contacts, toddler dermal contacts (such as a child hugging a dog), and toddler exposures resulting from hand-to-mouth activity following contact with treated pets. In addition, cancer risks were calculated for adults following dermal contact with treated pets.

The registrant submitted four post-application exposure studies which quantified dislodgeable fur residue on pets following application of powders, dips, aerosol and pump sprays. The data from these studies were used to determine maximum and average transfer rates for dermal contact with treated fur. In addition, assumptions with respect to body surface area, weight, and toddler hand-to-mouth activity were taken from the SOPs for Residential Exposure Assessment.

For the purposes of the carcinogenic residential post-application risk assessment, HED assumed post-application exposures were distributed over 7 days according to the calculated average and maximum transfer rates determined in the post-application studies. Doses and transfer rates were used to determine a time-weighted average exposure, which was multiplied by the Q_1^* and the number of days of exposure to determine cancer risk from post-application exposure. Assumptions used included 50 years of pet ownership over a 70-year lifetime.

Estimated short-term post-application risks were below HED's level of concern (i.e., MOEs >100) for adult dermal exposure to pets following treatment via dip, powder, aerosol, and pump spray. Estimated MOEs ranged from 1200-21,000, including both average and maximum application rates. For toddler dermal exposures, estimated MOEs for the same scenarios ranged from 93 to 1600; the MOE of 93 corresponded to the maximum application rate for aerosol application, and was the only MOE representing a risk at or just above HED's level of concern. For toddler hand-to-mouth exposures, estimated MOEs ranged from 110 to 1,300 for average and maximum dip scenarios, and average powder, aerosol and pump scenarios. Assuming maximum rates for powder, aerosol and pump, estimated toddler risk associated with hand-to-mouth activity exceeded HED's level of concern, with MOEs of 74 to 99.

Adult carcinogenic post-application risks were below HED's level of concern for all scenarios, with estimated risks ranging from 2.5×10^{-8} to 5.5×10^{-7} (including average and maximum rates). When handler and post-application cancer risks were combined, estimated risks ranged from 1.6×10^{-7} (aerosol can) to 3.6×10^{-6} (dip, using assumptions in residential SOPs) for average application rates, and from 3.3×10^{-7} (aerosol can) to 3.7×10^{-6} (dip, using assumptions in residential SOPs) for maximum application rates.

Carcinogenic risk associated with the use of multiple products containing tetrachlorvinphos was assessed. The registrant stated that the most likely combination consists of the use of a topical product and a pet collar. Post-application carcinogenic risk estimates for topical application and use of a pet collar were below HED's level of concern, ranging from 2.5×10^{-8} to 1.8×10^{-7} for average application rates and from 5×10^{-8} to 5.5×10^{-7} for maximum rates. However, when carcinogenic handler and post-application exposures were combined, assuming use of multiple products, HED's level of concern was exceeded for dip + flea collar at both average (3.7×10^{-6}) and maximum (3.8×10^{-6}) application rates. The powder + collar combination was not assessed. Other combined exposures (i.e., aerosol + collar, and pump + collar) resulted in cancer risks below the level of concern (2.9×10^{-7} to 7.0×10^{-7}).

The short-term risk associated with toddler oral (hand-to-mouth) exposure is considered to be an upper bound estimate, since the models use conservative estimates for residue transfer and ingestion (e.g., 50 percent of material on the hand is transferred) in each hand-to-mouth event. Although some conservative assumptions were used in assessing short-term dermal and carcinogenic post-application risk, HED also used the chemical specific data, even though there were concerns about quality of the data. Therefore HED cannot state the overall level of confidence in the estimated exposure and risk.

AGGREGATE EXPOSURE AND RISK ASSESSMENT

In accordance with the Food Quality Protection Act (FQPA, 1996), HED must consider and, if possible, aggregate pesticide exposures and risks from three major sources: food, drinking water, and residential exposures. In an aggregate assessment, exposures from relevant sources are added together and compared to quantitative estimates of hazard (e.g., a NOAEL or PAD), or the risks

themselves can be aggregated. When aggregating exposures and risks from various sources, HED considers both the route and duration of exposure. Based on the supported use pattern for tetrachlorvinphos, no exposure is expected to occur through consumption of drinking water; since acute aggregate risk assessments consider only food and water, the acute aggregate risk is equivalent to acute dietary (food only) risk (see Table 4). Dietary (food) and residential exposures were combined to determine aggregate short-term and cancer risks. All identified residential exposure scenarios were considered to be short-term in nature, and therefore an intermediate-term aggregate assessment was not conducted.

Since the NOAEL from the subchronic rat study was used to assess risk for acute dietary and short-term dermal and inhalation risks, the reciprocal MOE equation was used to calculate the aggregate MOE. The target aggregate MOE, below which HED would have concerns for aggregate exposure, is 100.

The following aggregate exposure and risk assessments were conducted using only those residential exposures that were estimated to be below HED's level of concern (i.e., MOEs greater than 100):

Short-term:

(1)	Residential Handler+Post-app. (adult):	Dietary (food)+Handler (dermal+inhalation) + Post-app. (dermal)
(2)	Residential Post-app. (toddler):	Dietary (food) + Post-app. (dermal) + Post-app. (oral, or hand-to-mouth)

The two corresponding equations used to calculate aggregate MOEs are as follows:

(1)

$$\text{MOEaggregate} = \frac{1}{\frac{1}{\text{MOE}_{\text{FOOD}}} + \frac{1}{\text{Handler (MOE}_{\text{DERMAL}}+_{\text{INHALATION}})} + \frac{1}{\text{Post-App. (MOE}_{\text{DERMAL}})}}$$

(2)

$$\text{MOEaggregate} = \frac{1}{\frac{1}{\text{MOE}_{\text{FOOD}}} + \frac{1}{\text{Hand-to-mouth (MOE}_{\text{ORAL}})} + \frac{1}{\text{Dermal (MOE}_{\text{DERMAL}})}}$$

For adults, MOE_{FOOD} was calculated by dividing the acute dietary NOAEL by the chronic dietary exposure for male and females (>20 years) based on anticipated residues (refer to Table 4). For toddlers, the dietary exposure for the most highly-exposed subgroup, children 1-6 was used. The MOEs corresponding to residential exposures are shown in detail in the attached document, the

HED Revised Occupational and Residential Exposure and Risk Assessment.

For assessing aggregate cancer risk for adults, dietary (food) cancer risks were added to the combined handler and post-application cancer risk estimates for adults. As in the case of short-term aggregate exposures, only residential scenarios with estimated risks below HED's level of concern were aggregated with dietary exposure. Details of estimated cancer risks for residential exposures are found in the attached occupational and residential exposure and risk assessment.

The results of the aggregate exposure assessments are presented in Tables 5 and 6.

Table 5. Summary of Tetrachlorvinphos Short-Term Aggregate Exposure and Risk Assessment.

Scenario Description[1]	Adult Handler MOE	Adult Post-app. MOE	Adult Aggregate MOE[2]	Toddler Dermal MOE	Toddler Oral MOE	Toddler Aggregate MOE[3]
Dip (Res. SOPs), 1 gal.; ave. rate				1600	1300	695
Collar (ave. rate)	300	n/a	298/298			
Collar (max. rate)	220	n/a	219/219			
Powder (ave. rate)				140	110	61
Powder (max. rate)				100	82	45
Aerosol (ave. rate)	3600	3000	1583/1587	220	180	99
Aerosol (max. rate)	3200	1200	857/859	93	74	41
Pump Spray (ave. rate)	5000	2600	1652/1657	190	150	84
Pump Spray (max. rate)	4800	1700	1224/1226	130	99	56

[1] The scenarios are described in detail in the 10/25/99 ORE Chapter. The registrant only provided post-application data for the sponge-on application of the dip; dip. For post-application exposures, average and maximum transfer rates were assumed for average and maximum application rates. Handler MOEs for applying dips and powders were <100, so exposures were not aggregated (for adults) for these scenarios.

[2] Adult aggregate MOEs include food, handler and post-application exposures, for males/females. No post-application exposure is expected for pet collars, so the adult aggregate MOE includes only food + handler exposures.

[3] Toddler aggregate MOEs include food, oral (hand-to-mouth) and dermal exposures, for post-application only, since HED assumes toddlers are not involved in pesticide application. Although unacceptable MOEs were obtained for maximum rate applications for some scenarios, they were aggregated for risk characterization purposes.

Table 6. Summary of Tetrachlorvinphos Aggregate Cancer Risk Assessment.[1]

Scenario Description	Cancer Risk (Handler + Post-app.) Single Product	Aggregate Cancer Risk[2] Single Product	Cancer Risk (Handler+Post-app.) Multiple Product	Aggregate Cancer Risk[3] Multiple Product
Dip	3.6×10^{-6}	3.8×10^{-6}	3.7×10^{-6}	3.9×10^{-6}
Collar	1.0×10^{-7}	2.8×10^{-7}	n/a	n/a
Powder	1.6×10^{-6}	1.8×10^{-6}	n/a	n/a
Aerosol	1.6×10^{-7}	3.4×10^{-7}	2.6×10^{-7}	4.4×10^{-7}
Pump Spray	3.8×10^{-7}	5.6×10^{-7}	2.9×10^{-7}	4.7×10^{-7}

[1] Detailed inputs to the table can be found in the 10/99 ORE chapter, and in the Dietary Exposure section of this document. Although some components of the aggregate cancer risk were above HED's level of concern, risks were aggregated for risk characterization purposes.

[2] Includes handler, post-application, and dietary (food) cancer risk, assuming use of a single product containing tetrachlorvinphos. Dietary food cancer risk for the general use population is estimated to be 1.8×10^{-7}.

[3] Includes handler, post-application, and dietary (food) cancer risk, assuming use of a topical product as well as a pet collar containing tetrachlorvinphos.

As shown in Table 5, aggregate short-term risk is generally below HED's level of concern for **adults**; estimated aggregate MOEs ranged from 219-4339 for aerosol can, pump spray, and collar scenarios. Since residential handler risk for dip and powder scenarios exceeded HED's level of concern, addition of dietary and post-application exposures would result in an aggregate risk above the level of concern.

Aggregate short-term risk for **toddlers** exposed to tetrachlorvinphos in residential settings is above HED's level of concern. Estimated MOEs ranged from 41-99 for post-application exposures associated with use of the powder, aerosol and pump spray. Although some conservative assumptions were used in determining individual components of aggregate risk, chemical-specific data were also used. Due to the poor quality of the data, HED cannot conclude if the assumptions and data used would be likely to over- or under-estimate exposure.

Aggregate cancer risks for adults were above HED's level of concern for dip scenarios and application of powders, with estimated risks ranging from 1.6×10^{-6} to 3.9×10^{-6} (including use of single and multiple, or topical plus collar, products). All other estimated aggregate cancer risks (i.e., for scenarios involving use of a collar, an aerosol can or a pump spray) were below HED's level of concern, with risks ranging from 2.8×10^{-7} to 5.6×10^{-7} for a single use of a product, and from 4.4×10^{-7} to 6.4×10^{-7} for use of a topical product in conjunction with application of a pet collar.

DATA REQUIREMENTS

Residue Chemistry

The residue chemistry data base is considered to be incomplete, largely due to the HED Metabolism Assessment Review Committee (MARC) decision to include 4 tetrachlorvinphos metabolites in the tolerance expression listed under 40 CFR §180.252. In most studies submitted to date, residues of the parent, tetrachlorvinphos were measured. The required residue chemistry data are essential to determine revised tolerance levels in livestock commodities:

OPPTS GLN No. 860.1340: Analytical methods capable of determining tetrachlorvinphos and metabolite residues in meat and milk are required.

OPPTS GLN No. 860.1380: Storage stability data are required for tetrachlorvinphos and its four metabolites in livestock tissues and milk.

OPPTS GLN No. 860.1480: Livestock dermal and feed-through treatment studies are required for poultry, swine and cattle (protocol under review). If all labels are not revised to prohibit treatment of horses intended for slaughter, dermal and feed-through treatment studies on horses are also required.

Occupational and Residential Exposure

Additional (higher quality) data would be useful to further refine the estimated dermal and inhalation exposures in residential sites, especially for the dip and powder scenarios (OPPTS Series 875 Group B Guidelines).